

Appl. No.: 10/633,269

Amendment Dated: 10/5/06

Reply to OA of 4/5/06

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AMENDMENT TO THE CLAIMS

The listing of the claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS

Please amend the claims as follows:

1 1. (Currently Amended) A method comprising:

2 exchanging two or more ultrawideband (UWB) signals with one or more target device(s),

3 each device recording a transmission strobe time and a receive strobe time associated with the

4 transmission and reception of such signal(s); and

5 exchanging the recorded transmission strobe time(s) and receive strobe time(s) associated

6 with the exchanged UWB signals from which one or more of a signal propagation time, timing

7 offset and frequency offset are computed; and

8 computing as a frequency offset between two devices a ratio of the clock frequency of the

9 first device with respect to the second device using the transmission and receive strobe times

10 associated with the exchange of a number (N) of ranging messages, in accordance with the

11 following equation:

12
$$f_o = \frac{T1_{TA} - T3_{TA}}{T1_{RB} - T3_{RB}} \Rightarrow f_o T1_{RB} - f_o T3_{RB} = T1_{TA} - T3_{TA}$$

13 where: T_{N_{TA}} is the recorded time of transmit of message N (1...3) at a first device(A);
 14 T_{N_{RB}} is the recorded time of reception of message N at a second device (B); and
 15 f_o is the frequency offset.

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1 2. (Original) A method according to claim 1, further comprising:
 2 computing as the signal propagation time and the timing offset the time delay between
 3 the transmission strobe time of an issuing device, and the receive strobe time at the target device.

1 3. (Original) A method according to claim 2, wherein the signal propagation time is computed
 2 after the exchange of at least two messages, M and M', in accordance with the following
 3 equation:

$$4 t_p = \frac{(T'_A - T_A) - (T'_B - T_B)}{2} = \frac{\text{distance}}{\text{signal_velocity}}$$

5 where: T_A is the recorded time of transmit of message M at a first device(A);
 6 T_B is the recorded time of reception of message M at a second device (B);
 7 T'_B is the recorded time of transmit of message M' at a second device (B); and
 8 T'_A is the recorded time of reception of message M' at the first device (A).

1 4. (Original) A method according to claim 3, wherein the time of reception (T_B , or T'_A)
 2 represents the time of transmission, signal propagation delay, and a timing offset between the
 3 device(s) (t_o).

1 5. (Cancelled) A method according to claim 2, further comprising:
 2 computing as a frequency offset between two devices a ratio of the clock frequency of the
 3 first device with respect to the second device using the transmission and receive strobe times
 4 associated with the exchange of a number (N) of ranging messages, in accordance with the
 5 following equation:

$$6 f_o = \frac{T1_{TA} - T3_{TA}}{T1_{RB} - T3_{RB}} \Rightarrow f_o T1_{RB} - f_o T3_{RB} = T1_{TA} - T3_{TA}$$

7 where: TN_{TA} is the recorded time of transmit of message N (1...3) at a first device(A);

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8 $T_{N_{RB}}$ is the recorded time of reception of message N at a second device (B); and
9 f_o is the frequency offset.

1 6. (Currently Amended) A method according to claim 5 1, wherein the number N is four
2 (4).

1 7. (Currently Amended) A method according to claim 5 1, wherein the signal propagation
2 time is computed after the exchange of at least four (4) messages in accordance with the
3 following equation:

4
$$t_p = \frac{f_o T_{1_{RB}} + T_{2_{RA}} - T_{1_{TA}} - f_o T_{2_{TB}}}{2}$$

5 where: f_o is the frequency offset identified between the two devices,
6 $T(N)_{TA}$: is the recorded time of transmit of message (N:1...3) from device (A),
7 $T(N)_{TB}$: is the recorded time of transmit of message (N:1...3) from device (B),
8 $T(N)_{RA}$: is the recorded time of receive of message (N:1...3) from device (A), and
9 $T(N)_{RB}$: is the recorded time of receive of message (N:1...3) from device (B).

1 8. (Original) A storage medium comprising content which, when implemented by an accessing
2 device, causes the device to implement a method of claim 7.

1 9. (Original) A method according to claim 1, further comprising:
2 detecting a transmission strobe time, or a reception strobe time by receiving an analog
3 representation of the message for transmission or upon reception, respectively, and denoting a
4 time when the analog representation of the message exceeds a threshold level.

1 10. (Currently Amended) An apparatus comprising:

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2 an ultrawideband (UWB) transceiver to transmit and/or receive ultrawideband wireless
3 signals; and
4 a ranging agent, coupled with the UWB transceiver, to exchange two or more
5 ultrawideband (UWB) signals with one or more target device(s), each device recording a
6 transmission strobe time and a receive strobe time associated with the transmission and reception
7 of such signal(s), and to exchange the recorded transmission strobe time(s) and receive strobe
8 time(s) associated with the exchanged UWB signals from which one or more of a signal
9 propagation time, timing offset and frequency offset are computed; and
10 a frequency offset compensation element, responsive to a control element, to receive
11 transmission and reception strobe times associated with the exchange of a number (N) of
12 messages, and to determine a frequency offset as a ratio of a ratio of the clock frequency of the
13 first device with respect to the second device.

1 11. (Original) An apparatus according to claim 10, the ranging agent comprising:
2 a precision timing engine, responsive to a control element, to generate and issue multiple
3 (N) messages via the UWB transceiver, to record the transmission and reception strobe time(s)
4 associated with the exchange of such messages, and to compute one or more of the signal
5 propagation time and the timing offset from which the proximal distance is determined.

1 12. (Original) An apparatus according to claim 11, the precision timing engine comprising:
2 a filter, to receive an analog representation of a message and generate a strobe signal once
3 the analog representation of the message reaches a threshold; and

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4 a latch element, coupled with the filter, to transfer an output of a counter to the control
5 element to record the counter output as a strobe time associated with the transmission or
6 reception of the message.

1 13. (Cancelled) An apparatus according to claim 10, the ranging agent comprising:
2 a frequency offset compensation element, responsive to a control element, to receive
3 transmission and reception strobe times associated with the exchange of a number (N) of
4 messages, and to determine a frequency offset as a ratio of a ratio of the clock frequency of the
5 first device with respect to the second device.

1 14. (Original) An apparatus according to claim 13, wherein the frequency offset compensation
2 element determines the frequency offset between the two devices in accordance with the
3 following equation:

$$4 \quad f_o = \frac{T1_{TA} - T3_{TA}}{T1_{RB} - T3_{RB}} \Rightarrow f_o T1_{RB} - f_o T3_{RB} = T1_{TA} - T3_{TA}$$

5 where: TN_{TA} is the recorded time of transmit of message N (1...3) at a first device(A);
6 TN_{RB} is the recorded time of reception of message N at a second device (B); and
7 f_o is the frequency offset.

1 15. (Original) An apparatus according to claim 14, wherein the number N of messages
2 exchanged between the devices to ensure that both devices have a complete set of transmission
3 and reception strobe times for both devices is four (4).

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1 16. (Original) An apparatus according to claim 14, wherein the control element determines the
2 propagation delay after the exchange of at least four (4) messages in accordance with the
3 following equation:

4
$$t_p = \frac{f_o T1_{RB} + T2_{RA} - T1_{TA} - f_o T2_{TB}}{2}$$

5 where: f_o is the frequency offset identified between the two devices,
6 $T(N)_{TA}$ is the recorded time of transmit of message (N:1...3) from device (A),
7 $T(N)_{TB}$ is the recorded time of transmit of message (N:1...3) from device (B),
8 $T(N)_{RA}$ is the recorded time of receive of message (N:1...3) from device (A), and
9 $T(N)_{RB}$ is the recorded time of receive of message (N:1...3) from device (B).

1 17. (Original) An apparatus according to claim 10, further comprising:
2 control logic, coupled with a memory element comprising executable content, to execute
3 at least a subset of the content to implement the ranging agent.

1 18. (Currently Amended) A system comprising:
2 one or more antenna(e);
3 a wireless transceiver, coupled with the antenna(e), to transmit/receive wireless signals in
4 support of communication between the system and a remote system; and
5 a ranging agent, coupled with the wireless transceiver, to exchange two or more wireless
6 signals with one or more target device(s), each device recording a transmission strobe time and a
7 receive strobe time associated with the transmission and reception of such signal(s), and to
8 exchange the recorded transmission strobe time(s) and receive strobe time(s) associated with the
9 exchanged wireless signals from which one or more of a signal propagation time, timing offset
10 and frequency offset are computed; and

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11 a frequency offset compensation element, responsive to a control element, to receive
12 transmission and reception strobe times associated with the exchange of a number (N) of
13 messages, and to determine a frequency offset as a ratio of a ratio of the clock frequency of the
14 first device with respect to the second device.

1 19. (Original) An system according to claim 18, the ranging agent comprising:
2 a precision timing engine, responsive to a control element, to generate and issue multiple
3 (N) messages via the wireless transceiver, to record the transmission and reception strobe time(s)
4 associated with the exchange of such messages, and to compute one or more of the signal
5 propagation time and the timing offset from which the proximal distance is determined.

1 20. (Cancelled) A system according to claim 18, the ranging agent comprising:
2 a frequency offset compensation element, responsive to a control element, to receive
3 transmission and reception strobe times associated with the exchange of a number (N) of
4 messages, and to determine a frequency offset as a ratio of a ratio of the clock frequency of the
5 first device with respect to the second device.